BACKLIGHTING AN LCD-BASED NOTEBOOK COMPUTER UNDER VARYING AMBIENT LIGHT CONDITIONS

FIELD OF THE INVENTION

This invention relates to the backlighting of multicolored liquid crystal displays under varying ambient lighting conditions, and more particularly to methods and means for backlighting such displays when used as an element in laptop computers.

DESCRIPTION OF RELATED ART

Liquid Crystals and Liquid Crystal Displays

It is known that in a liquid crystal (LC), particles, atoms or molecules tend to arrange themselves with a degree of order far exceeding that of ordinary liquids and approaching that of solid crystals. As a result, liquid crystals have many of the optical properties of solid crystals. Moreover, because its atomic or molecular order is not as firmly fixed as that of a solid crystal, a liquid can be easily modified by electromagnetic radiation, mechanical stress, or temperature with corresponding changes in its optical properties. Restated wryly, an LC is a collection of cigar-shaped organic molecules that exhibit an orientation order under appropriate pressure, temperature, and electro-optical field conditions.

A liquid crystal display (LCD) is an information display comprising a picture element (pixel) addressable array. This pixel-addressable array is formed from a thin layered sandwich of glass plates, polarizing filters, transparent electrodes, and liquid crystal material. The variety of electro-optical effects associated with LCs permit LCDs to be fashioned into different types of information displays. Because of the LCD's thin sandwich construction, the bulk associated with electron beam tube displays can be eliminated. Furthermore, many LCDs are reflective, meaning they use only ambient light to illuminate the display. Even where LCDs do require an external light source, they consume much less power than electron beam devices.

Passive And Active Matrix LCDs

LCDs are fashioned either as passive or active matrix devices. A passive matrix display is addressed by a set of multiplexed transparent electrodes, perpendicular to one another, above and below the LC layer in a row and column formation. A passive pixel is addressed when there is a sufficient voltage gradient across it to cause the LC molecules to align themselves parallel to the electric field.

In an active matrix display, addressing takes place completely behind the LC film. The front surface of the LCD is coated with a continuous electrode, while the rear surface is patterned as a pixel-addressable array. An array of thin film transistors (TFTs) operates to address corresponding pixels (LC cells) individually. That is, each TFT of a pixel is addressed by a set of narrow multiplexed electrodes running along the gaps between pixels. In turn, a pixel is addressed by applying current to a gate line which switches the TFT on and allows charge to go from the source line onto the rear electrode. This sets up a voltage across a pixel, turning it on.

An active matrix LCD does not suffer the limitations of a passive display. That is, it can be viewed at an angle of up to 45 degrees and has a contrast of 40 to 1. Disadvantageously, it requires more intense backlighting because neither the TFTs nor the gate or source lines are transparent and therefore block a fraction of the illuminating light.

Laptops, LCDs, and Display Lighting

A laptop is defined as a microcomputer small enough to use on one's lap. Laptops are also referenced as "notebook" computers. The latter stems from the fact that they may be closed and carried much like a closed book when not in use. Also, they may be opened up, as is a book, when being read. When so open, the display occupies the top lid or cover portion and is approximately vertical and hinged to the bottom lid or cover portion. Relatedly, the latter contains information entry and processing facilities, and is electrically and logically coupled to the LCD. Laptops may be plugged into an electrical outlet or more conveniently powered by internal battery for several hours.

Ambient light reflectively illuminates the opened display. However, the display is primarily sensed by emanations through an LCD of the active matrix, light-transmissive, multicolored type. Now, when the top lid is open, intense ambient light incident on the display may bleach out all or some of the presentation. This requires either that the cover position or the entire laptop be repositioned. Even the dynamic range of any backlighting may not be sufficient to overcome the intensity of the ambient light.

In this invention, attention is directed to the "transmissive" rather than the "reflective" or "transflective" LCDs. It is well appreciated that the color range, contrast ratio, viewing angles, etc. of transmissive active matrix LCDs far exceed the other types. All three types of LCDs include one or more polarizing layers in their layered sandwich which has a dimming effect on both reflected light and backlighting. The price paid in the case of active matrix LCDs is the backlighting requirement and the local battery drain when driving the laptop.

Backlighting and the Veglia, Yokoi, and Matsushita References

There are many backlighting arrangements. For example, it is well known to use a fluorescent light source for backlighting. Such a source is "light piped" onto a diffusing (defocusing lens) surface behind the LCD as a flat field illuminator thereof. Both the light source and the diffuser were invariantly positioned in fixed relation to each other.

It is broadly known from Veglia, FR 2,582,839 to backlight an LCD panel for use in a road vehicle, ship, or aircraft by way of a half-silvered mirror or equivalent forming a dihedral angle with the panel. The angle is acute enough such that ambient light incident on the mirror back is transmitted through the mirror to the LCD panel. Alternatively, if such light is insufficient, an artificial source reflects light over the opposite mirror surface, causing the light to be transmitted through the LCD panel.

Yokoi, U.S. Pat. No. 4,403,216, "Display", issued Sep. 6, 1983, discloses in FIGS. **2–4** an LCD flat panel display and a plane mirror forming an acute angle of opposing surfaces such that ambient light transmitted through the LCD may be viewed reflectively from the mirror (FIG. **3**), or such light reflected from the mirror may be viewed transmissively through the LCD (FIG. **4**).

Japanese Patent 63-18328, "External Light Reflecting Device for a Liquid Crystal TV Receiver", issued Jan. 26, 1988, to Matsushita Electric Co., discloses a tipped-up LCD panel movable in an angular relation with an opposing reflective surface in a first position, the LCD panel being illuminated through a back panel diffusion light source. When the LCD panel is raised to a second position, the diffusion source is turned off, and light incident to the back panel is reflectively transmitted through the LCD panel. The back panel can be formed from a half-silvered mirror. Significantly, the LCD panel is hinged approximately midway along the longitudinal extent of the notebook/TV, and is not hinged at the edges as are notebook or laptop computers.

SUMMARY OF THE INVENTION

It is accordingly an object of this invention to devise a unitary mechanical structure to enable the LCD portion of a